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LYGUS DESERTUS KNIGHT, 1944, A NEWLY RECOGNIZED SYNONYM OF *LYGUS ELISUS* VAN DUZEE, 1914 (HETEROPTERA: MIRIDAE)

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Abstract.—*Lygus desertus* Knight, 1944, is considered a **junior synonym** of *Lygus elisus* Van Duzee, 1914, based on a review of the literature and new morphometric, morphological, and distributional analyses.

Key Words: Miridae, *Lygus*, morphometrics, morphology, distribution

The genus *Lygus* Hahn currently includes 34 North American species (Kelton 1975, Henry and Wheeler 1988). Most Nearctic species occur in the western and northwestern United States and western Canada where several, such as *L. hesperus* Knight and *L. elisus* Van Duzee, are important pests of various crops.

The taxonomy of the genus and associated taxa is complex (Henry and Lattin 1987) and further complicated by the great amount of literature treating the group. Graham et al. (1984) listed more than 2400 citations concerning the *Lygus* complex (*Lygus* sensu lato as cataloged by Carvalho 1959) from 1900–1980. Despite the many taxonomic works already treating the genus *Lygus* and near relatives (e.g., Knight 1917, 1941, 1944, Kelton 1955a, b, c, 1975), positive identification of certain species remains difficult, even with type material available for comparison. Many of the host plant associations listed by several authors (e.g., Stitt 1949, Kelton 1975, Scott 1977, Fye 1980, Domek and Scott 1985) may require verification because of the species recognition problem.

While the broader problems of *Lygus* taxonomy have been discussed elsewhere (Henry and Lattin 1987), we address here a specific one between *L. desertus* Knight and *L. elisus* Van Duzee. Because these two species have been mentioned frequently in the applied literature and have been treated in considerable depth by staff of the U.S. Department of Agriculture's Biological Control of Insects Laboratory, Tucson, Arizona, we have gone to particular effort to document our reasons for considering *L. desertus* a junior synonym of *L. elisus*.

Taxonomic History

Knight (1944) described *L. desertus* from specimens taken in eight western states, with the holotype from Ajo, Arizona. He noted that *L. desertus* was closely related to *L. elisus*, but that it could be distinguished by the more elongate form, more convex scutellum, shorter and finer vestiture, and the slightly shorter rostrum. He also comment-

ed that the genital parameres were similar to those of *L. elisus* and, although there were small differences, these structures were not useful for sorting species.

Knight (1968) also provided the replacement name, *L. desertinus*, for *L. desertus* upon discovering that it was preoccupied by *Lygus desertus* Becker, 1864 (Carvalho 1959). Muminov (1986) showed that Becker's species belonged in the genus *Deraeocoris* Kirschbaum, thus removing *L. desertus* Knight from secondary homonymy (Henry and Wheeler 1988). *Lygus desertinus* is the name that appears in all of the economic literature to the present.

Kelton (1975: 39) maintained *L. desertus* (as *L. desertinus*) as a distinct species, but cautioned that it might be "confused with *elisus* as they are similar in size and color, and are often found together" and "the life history pattern appears to be similar to that of *elisus*." Kelton (1975) considered the color of the mesoscutum (partly pale in *L. desertus*, black in *L. elisus*) the most diagnostic character for distinguishing these two species.

Overview of Other Pertinent Literature

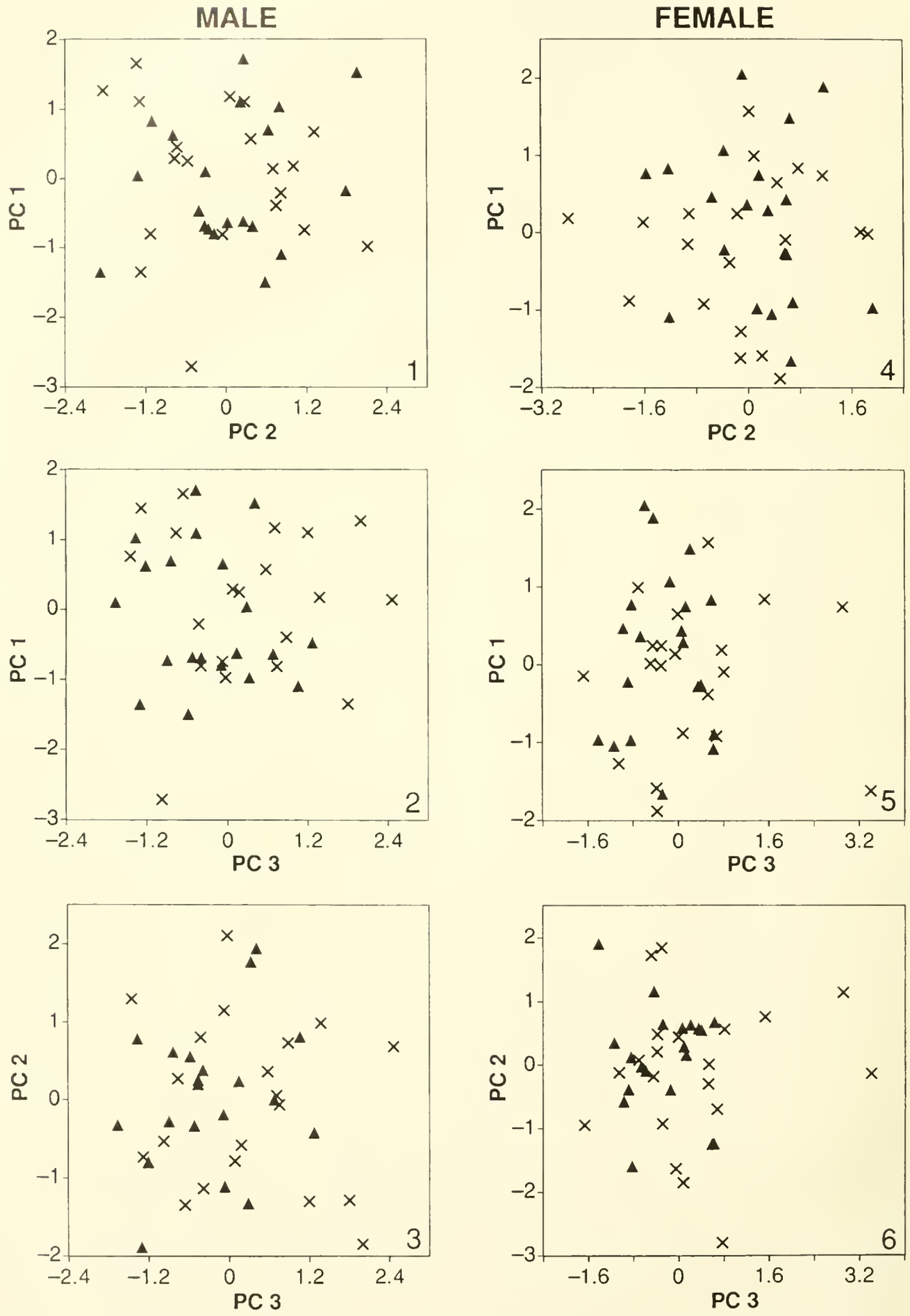
Specimens identified as *L. desertus* and *L. elisus* were documented to interbreed in three studies. Graham (1982) first questioned the distinctness of *L. desertus* (as *L. desertinus*) and *L. elisus* after showing that field-collected specimens interbreed in the laboratory. Sluss et al. (1982) considered laboratory crosses between *L. desertus* and *L. elisus* "very fertile," noting that only *L. elisus* female × *L. desertus* male crosses had a lower fertility than intraspecific ones, but that F1 progeny did not differ significantly from intraspecific crosses. Both Sluss et al. (1982) and Graham (1982) recorded variable mesoscutal color in *L. desertus* and *L. elisus* reared under similar conditions. Graham et al. (1987) provided detailed information showing that the two species readily interbreed in the laboratory, and speculated that the preference for *L. desertus* × *L. desertus* matings probably was the result of population differences or that it indicated *L. desertus* "is evolving toward a distinct species."

Preliminary data from Graham (1982) also indicated that the proportion of *L. desertus* without mesoscutal markings increased significantly when nymphs were reared at lower temperatures (at 20°C, 23% without markings versus 3% at 30°C without markings). Graham and Carranza (1983) confirmed that temperature influenced mesoscutal color, especially when late instars were exposed to cooler temperatures. They also reported, through personal communication with R. E. Fye (USDA, ARS, Yakima, WA), that the proportion of *L. elisus* individuals increased dramatically over those of *L. desertus* in late September and November in Washington.

Sluss et al. (1982) determined that *L. desertus* and *L. elisus* were morphologically "very similar" and distinct from *L. lineolaris* (Palisot) and *L. hesperus* Knight based on a morphometric study of rostral, tibial, antennal, pronotal and head lengths. Their study, which combined measurements of males and females diminished their results, but strongly suggests to us that the range of measurements for *L. desertus* and *L. elisus* was due to intraspecific variation. Their conclusion, based on morphological data, combined with somewhat inconclusive allozyme data, was the "*L. desertinus-elisus* complex . . . appears to be still in a subspecific state."

Other Supporting Evidence

Morphometric analysis: An ocular micrometer was used to measure 21 external characters of 20 male and 20 female specimens of both forms of *L. elisus* (as determined by mesoscutal coloration), from Utah, Box Elder Co., Cedar Hills, 11 August 1972. The measurements were—length from apex of tylus to: apex of membrane (1), apex of abdomen (2), cuneal fracture (3); length



Figs. 1–6. Principal component ordination of 40 male and 40 female specimens of *L. elisus* Van Duzee (Utah, Box Elder Co., Cedar Hill) based on the analysis of 21 measurements. 1–3. Males. 1. First and second principal axes. 2. First and third principal axes. 3. Second and third principal axes. 4–6. Females. 4. First and

of cuneus (4); width across widest portion of hemelytra (5); medial length of pronotum (6); posterior width of pronotum (7); width of: pronotal collar (8), head across eyes (9); interocular width at: vertex (10), frons near antennal fossa (11); length of head from apex of tylus to carina of vertex (12); length from apex of tylus to margin of eye near antennal fossa (13); width of eye in dorsal view (14); length of antennal segment: 1 (15), 2 (16), 3 (17), 4 (18); length of: rostrum (19), rostral segment 1 (20), metatibia (21). We applied principal component analysis to the measurements using SPSS PC+ (Norusis 1988). The measurements of the same sex from each form were combined and then the sexes were analyzed separately. Combining the data from each form allowed us to find relationships among measurements and among individuals in each analysis. The character scores on the first three principal components, accounted for 55.6% of total variation of males and 53.3% of total variation of females. The projection of the individual specimens onto combinations of the first three principal axes is shown in Figs. 1–6. The first principal component (PC 1, 35.2% male, 35.3% female) weakly reflected general size variation among the individuals. The second and third principal components (PC 2, 11.5% male, 9.5% female; PC 3, 8.9% male, 8.5% female) showed very weak shape variation. The results shown in Figs. 1–6 clearly do not separate the specimens of either sex into distinct species groups.

Male genitalia: The number and placement of the sensory lobe spines are the most variable features of the left paramere (Fig. 9). We were unable to detect any consistent differences among specimens of either *L. elisus* form. The right paramere (Fig. 8) is practically uniform throughout the genus. The shape of the two spinose fields of the vesica and the conformation of the single spicule of the vesica are also variable (Figs. 7, 10). The intra-population variability in the spicule is as great as the variability found in specimens at the latitudinal extremes of the distribution of *L. elisus* (Figs. 11–22). The great variability of the spiculae within this one species of *Lygus* illustrates the diminished taxonomic utility of this structure to discriminate species in the genus.

Vestiture: Although we observed some difference in the hemelytral pubescence, we feel this is individual variation, as is often found in *L. lineolaris*. Specimens in collections may be segregated into two groups, those with more sparse and shorter pubescence are *L. desertus*; those with longer setae are *L. elisus*. Individuals with shorter setae appear more shiny than those bearing heavier pubescence.

Length of rostrum: Although Knight (1944) claimed that the rostrum of *L. desertus* was shorter than in *L. elisus*, we were unable to observe this difference. Our findings corroborate those of Kelton (1975).

Distribution and host plants: We found both forms in many series that were collected at the same locality and time on the same host plant (see Appendix). Our findings agree with those of Kelton (1975): these species are sympatric on the same host.

Mesoscutal color: This character is the primary reason *L. desertus* and *L. elisus* have been maintained as separate species. We have studied many series of specimens in the Canadian and U.S. National Collections and two from reared material made available to us by H. Graham (USDA Tucson Lab.) and have found they all contain a mixture of individuals exhibiting either dark, yellow-marked, or intermediate-colored mesoscuta. The intra-population variation

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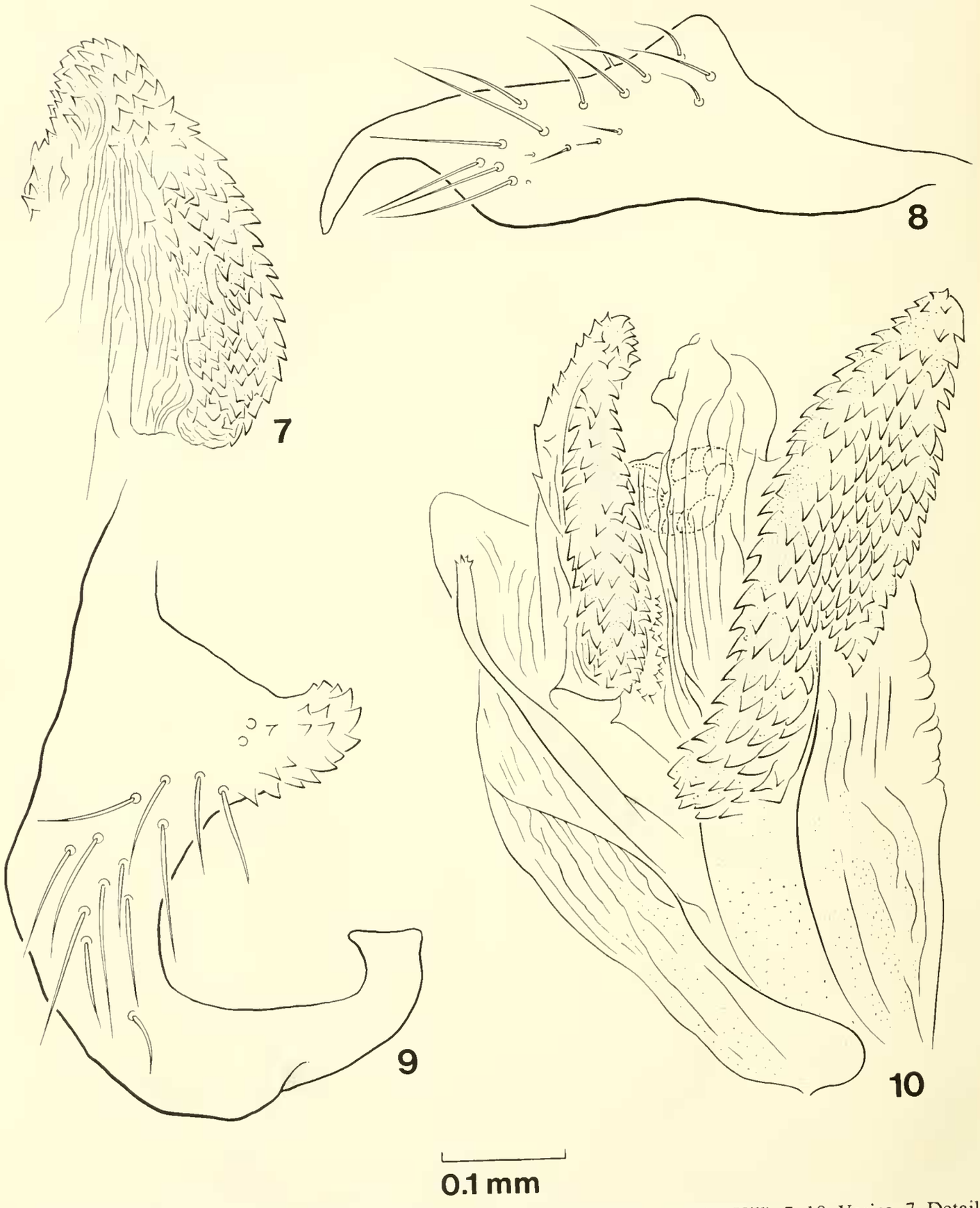
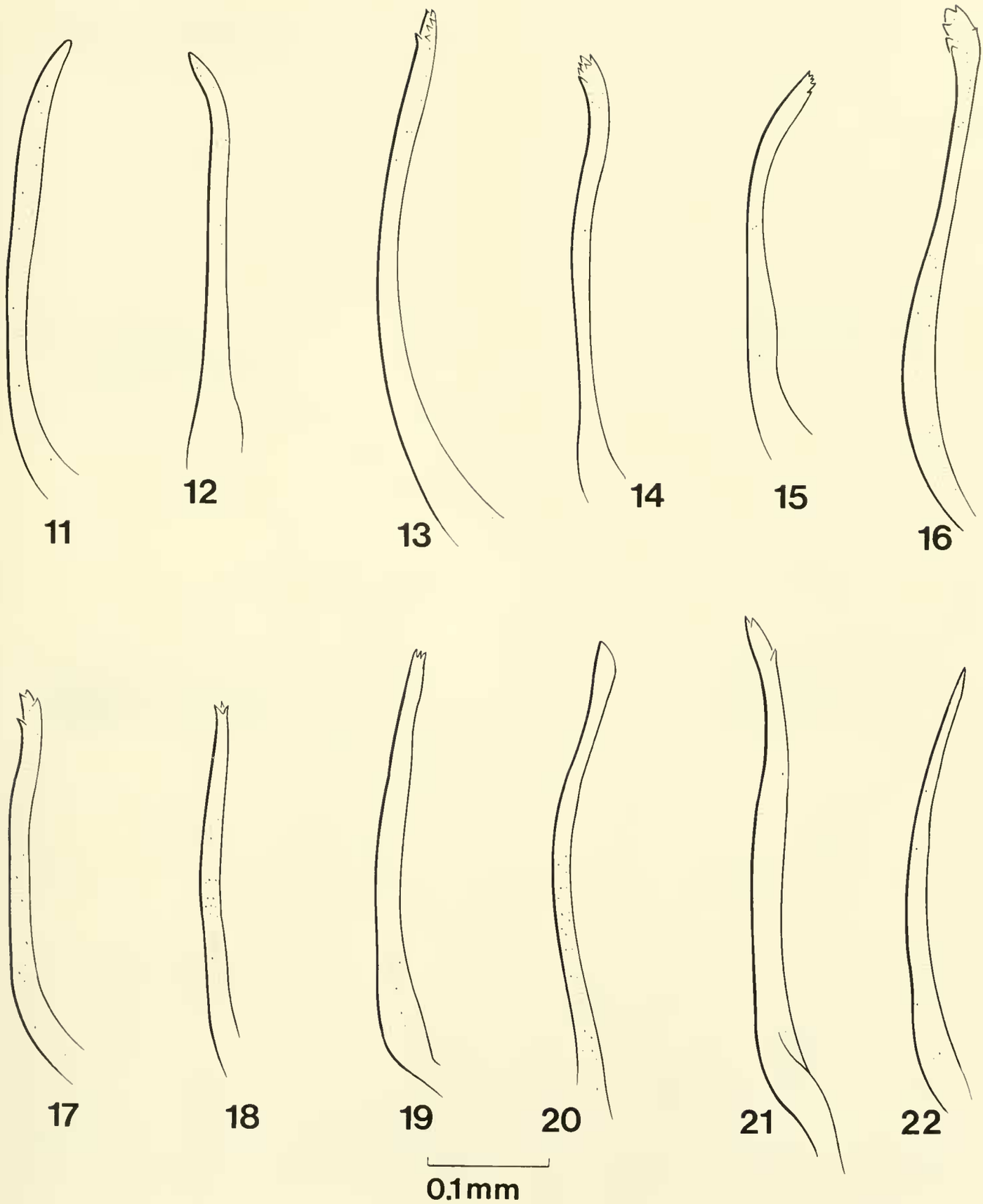
second principal axes. 5. First and third principal axes. 6. Second and third principal axes. ▲ = *L. elisus—elisus* form. × = *L. elisus—desertus* form.

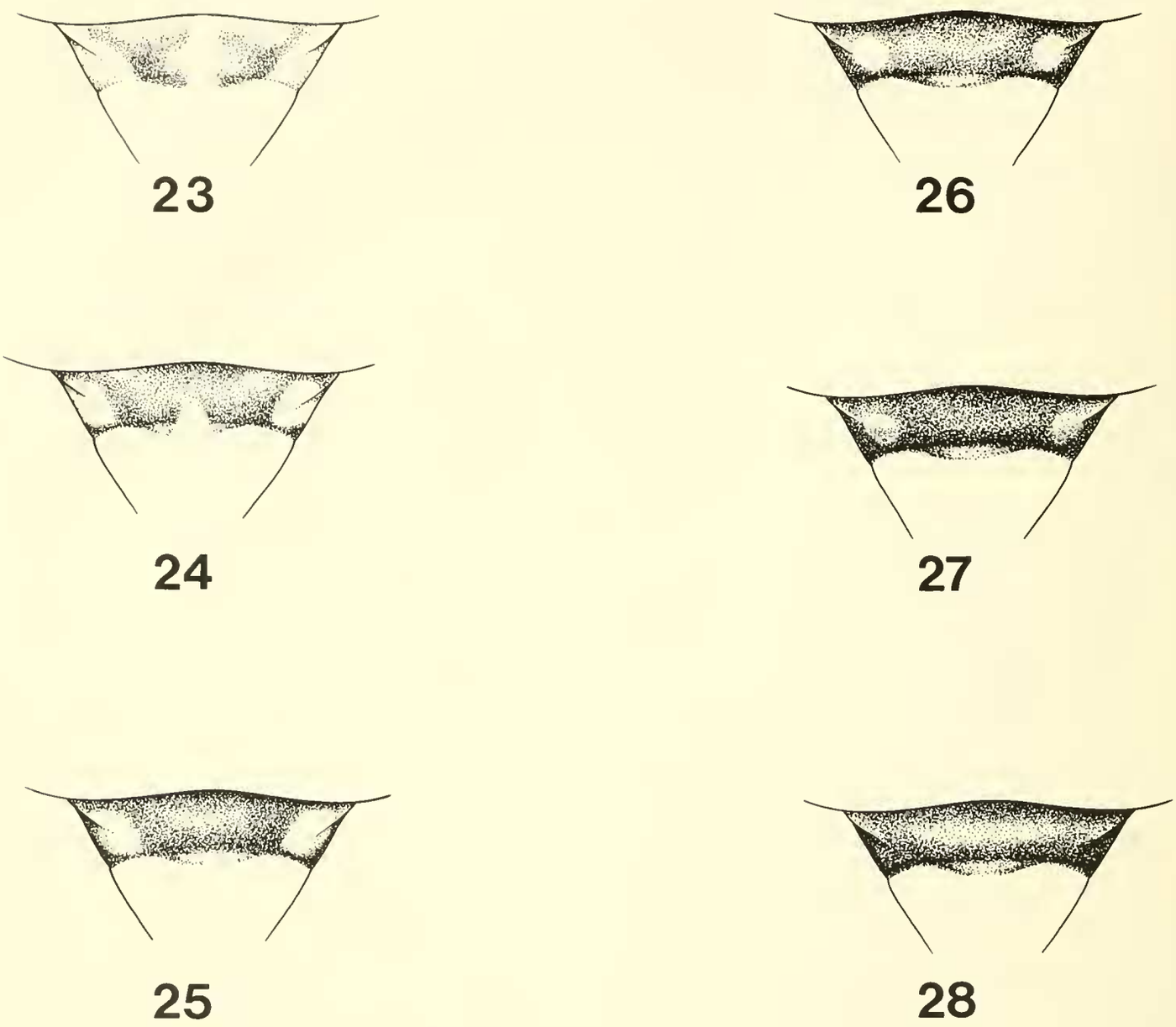


Figs. 7–10. Male genitalia of *L. elisus* Van Duzee (Utah, Box Elder Co., Cedar Hill). 7, 10. Vesica. 7. Detail of left spinose field, left lateral view. 10. Vesica, anterior view. 8, 9. Parameres, lateral view. 8. Right. 9. Left.

of the mesocutal color pattern exhibited in a single collection from Utah, Box Elder Co., Cedar Hills (Figs. 23–28) spans the variation found across the entire species. The distribution of the forms of *L. elisus*, as determined by the mesoscutal pattern, varies with respect to temperature (Graham and Carranza 1983) and this variation is



Figs. 11–22. Detail of vesical spiculae of *L. elisus* Van Duzee. 11–18. Utah, Box Elder Co., Cedar Hill. 11–14. *L. elisus—elisus* form. 15–18. *L. elisus—desertus* form. 19, 20. Southern localities. 19. *L. elisus—desertus* form, Texas, Brewster Co., Big Bend Nat'l. Park, Santa Elena Cyn. 20. *L. elisus—elisus* form, Texas, Jeff Davis Co., Ft. Davis. 21, 22. Northern localities. 21. *L. elisus—desertus* form, Yukon Territory, Takini Hot Sprgs. 22. *L. elisus—elisus* form, Northwest Territories, Ft. Simpson.



Figs. 23–28. Mesoscuta of *L. elisus* Van Duzee, Utah, Box Elder Co., Cedar Hill.

reflected by latitude (Fig. 29). There is a predominance of the *elisus* form in the northern portion of the range and a predominance of the *desertus* form in the southern portion of the range. The graphic representation of this correlation was based on the study of more than 3500 specimens including material collected from all times of the year, and averaging the proportion of the *L. elisus* form from the same locality from early and late in the year (see Appendix collection numbers 5 and 6, 81 to 84, 86 and 87). We note that most of the laboratory-reared offspring seem to reflect the parent-type mesoscutum when reared under similar conditions, as was indicated by Graham (1982), Sluss et al. (1982), and Graham and Carranza (1983). In field-collected ma-

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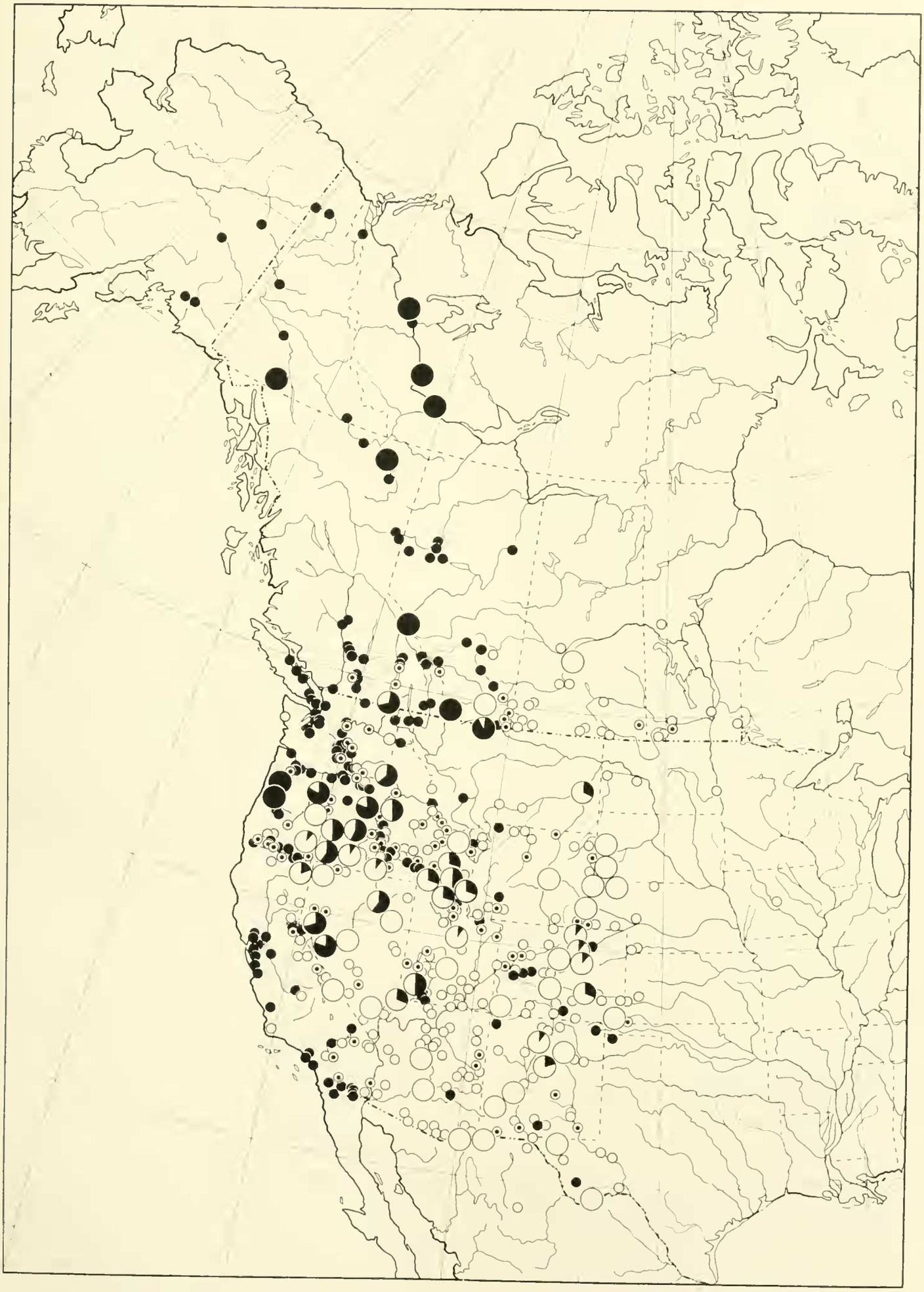
Fig. 29. Distribution of forms of *L. elisus* Van Duzee. Large circles—locality with 10 or more specimens (n = 10 to 374, $\bar{x}$ = 24, see Appendix for complete locality data); black portion of pie represents proportion of *elisus* form of total number of specimens in 10% increments (rounded to nearest 10%). Small circles—locality with less than ten specimens; ● *elisus* form, ○ *desertus* form, ⊙ *elisus* and *desertus* form.



terial, however, we have observed much more variation, suggesting that seasonal and daily temperature fluctuations affect more individuals and, perhaps, more matings involve pairs with mixed mesoscutal types.

Conclusion

The color of the mesoscutum, the chief character used to separate *L. desertus* and *L. elisus,* varies both within populations reared under similar conditions and in those affected by variable temperatures. That both color types (and intermediates) are often found in the field together on the same host plants, readily interbreed in the laboratory, and produce fertile offspring eliminates arguments for sexual isolation, or even subspecies consideration. Accordingly, based on this and other information gathered from the literature, and on the analyses of museum specimens presented here, we are convinced that *L. desertus* is a color morph of *L. elisus.*

The following synonymic list, modified from Henry and Wheeler (1988), updates the names we consider conspecific with *L. elisus*:

Lygus elisus Van Duzee

Lygus pratensis var. *elisus* Van Duzee, 1914: 20.

Lygus elisus: Van Duzee, 1916: 40.

Lygus (*Lygus*) *elisus* var. *viridiscutatus* Knight, 1917: 575. Synonymized by Kelton, 1975: 36.

Lygus nigrosignatus Knight, 1941: 270. Synonymized by Kelton, 1975: 37.

Lygus desertus Knight, 1944: 471. NEW SYNONYM.

Liocoris elisus: Kelton, 1955c: 548.

Liocoris desertus: Kelton, 1955c: 548.

Liocoris nigrosignatus: Kelton, 1955c: 552.

Lygus desertinus Knight, 1968: 189. New name for *Lygus desertus* Knight, a secondary homonym preoccupied by *Lygus desertus* Becker, 1864; homonymy eliminated by Muminov, 1986: 41 (see also Henry and Wheeler 1988: 322–323).

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Literature Cited

Carvalho, J. C. M. 1959. Catalogue of the Miridae of the world. Part IV. Mirinae. Arquivos do Museu Nacional, Rio de Janeiro 48(4): 1–384.

Domek, J. M. and D. R. Scott. 1985. Species of the genus *Lygus* Hahn and their host plants in the Lewiston-Moscow Area of Idaho (Hemiptera: Miridae). Entomography 3: 75–105.

Fye, R. E. 1980. Weed sources of *Lygus* bugs in the Yakima Valley and Columbia Basin in Washington. Journal of Economic Entomology 73: 469–473.

Graham, H. M. 1982. Interbreeding of *Lygus elisus* Van Duzee and *L. desertinus* Knight in the field. Southwestern Entomologist 7: 60–64.

Graham, H. M. and R. L. Carranza. 1983. Mesoscutal markings of *Lygus desertinus* Knight as affected by temperature. Southwestern Entomologist 8: 190–193.

Graham, H. M., A. A. Negm, and L. R. Ertle. 1984. Worldwide literature of the *Lygus* complex (Hemiptera: Miridae), 1900–1980. United States Department of Agriculture, Bibliography and Literature of Agriculture 30: 1–205.

Graham, H. M., B. J. Schaeffer, and R. L. Carranza. 1987. *Lygus elisus* and *L. desertinus*: Mating characteristics and interactions. Southwestern Entomologist 12: 1–6.

Henry, T. J. and J. D. Lattin. 1987. The taxonomic status, biological attributes, and recommendations for future work on the genus *Lygus* (Heteroptera: Miridae), pp. 54–68. *In* Hedlund, R. and H. M. Graham, eds., Economic Importance and Biological Control of *Lygus* and *Adelphocoris* in North America. United States Department of Agriculture, Agriculture Research Publication 64. 95 pp.

Henry, T. J. and A. G. Wheeler, Jr. 1988. Family Miridae Hahn, 1833 (=Capsidae Burmeister, 1835). The plant bugs, pp. 251–507. *In* Henry, T. J. and R. C. Froeschner, eds., Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States. E. J. Brill, Leiden and New York. 958 pp.

Kelton, L. A. 1955a. Genera and subgenera of the *Lygus* complex (Hemiptera: Miridae). Canadian Entomologist 87: 277–301.

———. 1955b. New species of *Liocoris* from North America (Hemiptera: Miridae). Canadian Entomologist 87: 484–490.

———. 1955c. Species of *Lygus, Liocoris,* and their allies in the Prairie Provinces of Canada (Hemiptera: Miridae). Canadian Entomologist 87: 531–556.

———. 1975. The *Lygus* bugs (genus *Lygus* Hahn) of North America (Heteroptera: Miridae). Memoirs of the Entomological Society of Canada 95: 1–101.

Knight, H. H. 1917. A revision of the genus *Lygus* as it occurs in America north of Mexico, with biological data on the species from New York. Cornell University of Agriculture Experiment Station Bulletin 391: 555–645.

———. 1941. New species of *Lygus* from western United States (Hemiptera: Miridae). Iowa State College Journal of Science 15: 269–273.

———. 1944. *Lygus* Hahn: Six new species from western North America (Hemiptera, Miridae). Iowa State College Journal of Science 18: 471–477.

———. 1968. Taxonomic review: Miridae of the Nevada Test Site and the western United States. Brigham Young University Science Bulletin Biological Series 9(3): 1–282.

Muminov, N. N. 1986. Middle-Asiatic species of the genus *Deraeocoris* Kbm. (Heteroptera, Miridae) [in Russian]. Izvestiya Akademii Nauk Tadzhikskoi SSR Otdelenie Biologicheskikh Nauk 101: 39–41 (1985).

Norusis, M. J. 1988. SPSS/PC+ V2.0 Base Manual for the IBM PC/XT/AT and PS/2. SPSS Inc., Chicago, Ill.

Scott, D. R. 1977. An annotated list of host plants of *Lygus hesperus* Knight. Bulletin of the Entomological Society of America 23: 19–22.

Sluss, T. P., H. M. Graham, and E. S. Sluss. 1982. Morphometric, allozyme, and hybridization comparisons of four *Lygus* species (Hemiptera: Miridae). Annals of the Entomological Society of America 75: 448–456.

Stitt, L. L. 1949. Host plant sources of *Lygus* spp. infesting the alfalfa seed crop in southern Arizona and southeastern California. Journal of Economic Entomology 42: 93–99.

Van Duzee, E. P. 1914. A preliminary list of the Hemiptera of San Diego County, California. Transactions of the San Diego Society of Natural History 2: 1–57.

———. 1916. Check List of the Hemiptera (Excepting the Aphididae, Aleurodidae and Coccidae) of America, North of Mexico. New York Entomological Society, New York. xi + 111 pp.

Appendix

List of localities with 10 or more specimens of either *elisus* form and *desertus* form of *Lygus elisus,* or a combination of both forms[1]

Canada:

1. ALBERTA: Coutts: 15 June 1952, A. R. Brooks (13:1); L. A. Konotopetz. (23:1). Total: 36:2 **95%** (CNC)
2. ALBERTA: Crowsnest, 19 July 1974, L. A. Kelton, ex *Artemisia.* (19:0) **100%** (CNC)
3. ALBERTA: Jasper, 29 Aug. 1970, L. A. Kelton. (19:0) **100%** (CNC)
4. ALBERTA: Lethbridge, 5 July 1956, E. E. Sterns. (0:11) **0%** (CNC)

[1] Order of appendix data: collection number, locality(ies) contributing to percentage, n = ratio of *elisus* form to *desertus* form, percentage of *elisus* form, institution; collections numbers in parentheses are combined with other similar localities, bold percentages are used in Fig. 29.

(5.) BRITISH COLUMBIA: Oliver: 13 Apr. 1923, C. B. Garrett (1:0); 23 Apr. 1923, C. B. Garrett (1:0); 24 Apr. 1923, C. B. Garrett (1:0); 26 Apr. 1923, C. G. Garrett (1:0); 14 May 1948, ex alfalfa (2:0); 14 May 1959, L. A. Kelton (11:0); 14 May 1959, R. Madge (1:0); 20 June 1975, L. A. Kelton (1:0). Total: (19:0) 100% (CNC)

(6.) BRITISH COLUMBIA: Oliver, 19 July 1970, L. A. Kelton, ex *Artemisia* (0:3); 12 Aug. 1953, D. F. Hardwick (1:1); 1000′, 17 Aug. 1953, J. E. H. Martin (0:1). 23 Aug. 1953, J. R. McGillis (1:0); 25 Aug. 1953, J. E. H. Martin (1:1); 26 Aug. 1953, J. E. H. Martin (1:0). Total: (4:6) 40% (CNC); #5 and #6 **74%**

7. BRITISH COLUMBIA: Summit Lk., mi 392 Alaska Hwy., 8 July 1959, 4500′, R. E. Leech, ex yarrow. (15:0) **100%** (CNC)

(8.) NORTHWEST TERRITORIES: Norman Wells, 19 May 1953, J. S. Waterhouse. (13:0) 100% (CNC)

(9.) NORTHWEST TERRITORIES: Norman Wells, 21 June 1969, G. E. Shewell. (33:1) 97% (CNC); #8 and #9 **99%**

(10.) NORTHWEST TERRITORIES: Ft. Simpson, 14 June 1950, D. P. Whillans. (16:1) 94% (CNC)

(11.) NORTHWEST TERRITORIES: Ft. Simpson, 19 Aug. 1950, D. P. Whillans. (37:1) 97% (CNC); #10 and #11 **96%**

12. NORTHWEST TERRITORIES: Wrigley, 14 June 1969, G. E. Shewell. (23:0) **100%** (CNC)

13. YUKON TERRITORY: Takini Hot Sprgs., 19 Aug. 1962, R. E. Leech, ex *Artemisia*. (56:0) **100%** (CNC)

(14.) SASKATCHEWAN: Saskatoon, 28 Apr. 1949, A. R. Brooks, ex *Salix* sp. (0:16) 0% (CNC)

(15.) SASKATCHEWAN: Saskatoon, 5 July 1950, A. R. Brooks, ex *Chenopodium album*. (0:11) 0% (CNC); #14 and #15 **0%**

United States:

16. ARIZONA: *Cochise Co.:* Tombstone, 12 May 1978, B. L. Rozen & R. Goelet. (0:12) **0%** (NYC)

17. ARIZONA: *Gila Co.:* 8 mi SW of jct. of Rts. 87 & 188 (off Rt. 87), Tonto Nat'l. For., 4000′, 27–28 May 1983, R. T. Schuh & G. M. Stonedahl, ex MV lite. (0:17) **0%** (AMNH)

18. ARIZONA: *Yavapai Co.:* Prescott, 16 Aug. 1972, L. A. Kelton. (0:14) **0%** (CNC)

19. CALIFORNIA: *Modoc Co.:* 4 mi E of Cedarville, 1440 m, 2 July 1979, R. T. Schuh, B. M. Massie, ex *Sarcobatus vermiculatus* (2:6); 2 mi E of Cedarville, 1440 m, 1 July 1979, R. T. Schuh, B. M. Massie, ex *Sarcobatus vermiculatus* (Chenopodiaceae) (0:1); 24.7 mi NW of Canby, 1375 m, 1 July 1979, R. T. Schuh, B. M. Massie (0:2). Total: (2:9) **18%** (AMNH)

20. CALIFORNIA: *Mono Co.:* 20 mi N of Bishop, 7000′, 5 Aug. 1962, D. R. Smith. (0:13) **0%** (OSU)

21. COLORADO: *Baca Co.:* Regnier, 37°00′N 102°50′W, 4500′, 6–9 June 1919. (1:19) **5%** (AMNH)

22. COLORADO: *Boulder Co.:* Boulder, 5400′, 10 June 1961, B. H. Poole. (2:19) **10%** (CNC)

(23.) COLORADO: *Boulder Co.:* Nederland, 8200′, 29 June 1961, J. R. Stainer. (1:15) 6% (CNC)

(24.) COLORADO: *Boulder Co.:* Nederland, Science Lodge, 9500′, 4 July 1961, J. R. Stainer. (0:19) 0% (CNC)

(25.) COLORADO: *Boulder Co.:* Nederland, Science Lodge, 9500′, 5 July 1961, J. R. Stainer. (0:11) 0% (CNC)

(26.) COLORADO: *Chaffee Co.:* Buena Vista, 7800′, 22–23 June 1961, J. R. Stainer. (2:67) 3% (CNC)

(27.) COLORADO: *Chaffee Co.:* Buena

Vista, 9000′, 22 June 1961, J. R. Stainer. (0:15) 0% (CNC); #26 and #27 **2%**

(28.) COLORADO: *Clear Creek Co.:* Doolittle Ranch, Mt. Evans, 9800′, 8 July 1961, J. R. Stainer. (2:13) 13% (CNC)

(29.) COLORADO: *Clear Creek Co.:* Doolittle Ranch, Mt. Evans, 9800′, 9 July 1961, J. R. Stainer. (0:23) 0% (CNC)

(30.) COLORADO: *Clear Creek Co.:* Doolittle Ranch, Mt. Evans, 9800′, 17 July 1961, J. R. Stainer. (0:18) 0% (CNC)

(31.) COLORADO: *Clear Creek Co.:* Mt. Evans, 12,000′, 3 Aug. 1961, B. H. Poole. (1:16) 6% (CNC)

(32.) COLORADO: *Clear Creek Co.:* Mt. Evans, 12,000′, 3 Aug. 1961, B. H. Poole. (1:14) 7% (CNC)

(33.) COLORADO: *Clear Creek Co.:* Summit Lk., Mt. Evans, 12,800′, 10 July 1961, W. R. M. Mason. (0:18) 0% (CNC)

(34.) COLORADO: *Clear Creek Co.:* Summit Lk., Mt. Evans, 12,800′, 16 July 1961, J. R. Stainer. (3:52) 5% (CNC)

(35.) COLORADO: *Clear Creek Co.:* Summit Lk., Mt. Evans, 12,800′, 24 July 1961, J. R. Stainer. (0:21) 0% (CNC)

(36.) COLORADO: *Clear Creek Co.:* Timberline, Mt. Evans, 11,600′, 13 July 1961, J. R. Stainer. (0:21) 0% (CNC); #23–#25, #28–#36 **3%**

37. COLORADO: *Douglas Co.:* 1 mi S of Parker, along Cherry Crk., 1780 m, 20 May 1978, J. T. Polhemus & R. T. Schuh. (1:9) **10%** (AMNH)

38. COLORADO: *El Paso Co.:* Colorado Sprgs., 27 June 1966, J. A. Slater. (3:7) **30%** (AMNH)

(39.) COLORADO: *Larimer Co.:* Estes Park, 7500′, 2 July 1961, J. R. Stainer. (2:16) 11% (CNC)

(40.) COLORADO: *Larimer Co.:* Estes Park, 7500′, 20 July 1961, J. R. Stainer. (1:70) 1% (CNC)

(41.) COLORADO: *Larimer Co.:* Estes Park, 7500′, 10 Aug. 1961, J. R. Stainer. (2:9) 18% (CNC); #39–#41 **10%**

42. COLORADO: *Montezuma Co.:* Cortez, 19 July 1968, L. A. Kelton, ex *Chenopodium.* (0:10) **0%** (CNC)

43. IDAHO: *Adams Co.:* Mesa, 4 Aug. 1972, L. A. Kelton, ex *Chenopodium.* (13:12) **52%** (CNC)

44. IDAHO: *Bear Lake Co.:* Montpelier, 42°19′N, 111°18′W, 6100′, 6 July 1920. (3:8) **27%** (AMNH)

(45.) IDAHO: *Bingham Co.:* 6 mi SW of Blackfoot, 28 June 1977, J. M. Domek, ex *Medicago sativa.* (8:18) 30% (UID)

(46.) IDAHO: *Butte Co.:* 18 mi NE of Howe, 17 Aug. 1965, R. L. Westcott. (10:21) 32% (UID); #45–#46 **31%**

47. IDAHO: *Cassia Co.:* 5 mi NW of Oakley, 21 June 1965, W. F. Barr, ex *Eurotia lanata.* (7:15) **32%** (UID)

48. IDAHO: *Jefferson Co.:* 4.5 mi NW of Terreton, 14 June 1972, J. M. Domek, ex *Chaenactis* sp. (0:14) **0%** (UID)

49. IDAHO: *Oneida Co.:* Rock Crk., 29 June 1972, G. F. Knowlton. (7:6) **54%** (OSU)

50. IDAHO: *Owyhee Co.:* 13 mi SE of Murphy, 4 Sept. 1962, W. F. Barr, ex *Chyrsothamnus viscidiflorus.* (2:13) **13%** (UID)

51. MONTANA: *Prairie Co.:* Fallon, 8 Aug. 1962, J. G. & B. L. Rozen. (3:8) **27%** (AMNH)

(52.) NEBRASKA: *Sheridan Co.:* Hay Sprgs., 28 June 1973, L. A. Kelton, ex alfalfa. (0:27) 0% (CNC)

(53.) NEBRASKA: *Sheridan Co.:* Hay Sprgs., 28 June 1973, L. A. Kelton, ex *Symphoricarpos.* (0:14) 0% (CNC); #52 and #53 **0%**

54. NEBRASKA: *Sioux Co.:* 7 mi N of Harrison, 13 Aug. 1962, J. G. & B.

L. Rozen, ex *Helianthus.* (3:57) **5%** (AMNH)

55. NEVADA: *Elko Co.:* Elko, 30 Aug. 1967, L. A. Kelton, ex rabbitbrush. (14:11) **56%** (CNC)
56. NEVADA: *Elko Co.:* E side of Ruby Mts., nr. Thompson Crk., T31N R59E, 6300′, 26 June 1983, R. T. Schuh & M. D. Schwartz, ex *Lupinus* sp. (Fabaceae). (0:11) **0%** (AMNH)
57. NEVADA: *Lander Co.:* 1.5 mi S of Rt. 50 on Rt. 376, T18N R45E, 5900′, 28 June 1983, R. t. Schuh & M. D. Schwartz, ex *Grayia spinosa* (Hook.) Moq. (Chenopodiaceae). (0:10) **0%** (AMNH)
58. NEVADA: *Nye Co.:* 2.5 mi NE of Gabbs, off Rt. 844 at Gabbs Rifle Range, 4800′, 2 July 1983, R. T. Schuh & M. D. Schwartz, ex MV lite. (10:2) **83%** (AMNH)
59. NEVADA: *Nye Co.:* Nevada Atomic Test Site, S of GS500 on Jackass Flats Rd., 3300′, (A25), 6 June 1983, R. T. Schuh, M. D. Schwartz & G. M. Stonedahl, ex *Franseria dumosa* Gray (Asteraceae). (2:9) **0%** (AMNH)
60. NEVADA: *Washoe Co.:* 6 mi W of Vya toward Cedarville, 1810 m, 2 July 1979, R. T. Schuh & B. M. Massie, ex *Chrysothamnus* sp. (Asteraceae). (0:19) **0%** (AMNH)
61. NEVADA: *Washoe Co.:* Wadworth, 30 Aug. 1967, L. A. Kelton, ex *Ambrosia.* (20:7) **74%** (CNC)
62. NEW MEXICO: *Grant Co.:* Roberts' Lk. Gila Nat'l. For., 19 Aug. 1972, L. A. Kelton. (0:20) **0%** (CNC)

(63.) NEW MEXICO: *Hidalgo Co.:* 23 mi S of Animas, 28 Aug. 1975, J. G. Rozen & R. McGinley. (0:23) 0%

(64.) NEW MEXICO: *Hidalgo Co.:* 23 mi S of Animas, 30 Aug. 1975, J. G. & K. C. Rozen. (1:14) 7% (AMNH)

(65.) NEW MEXICO: *Hidalgo Co.:* 25 mi S of Animas, 30 Aug. 1975, J. G. & K. C. Rozen. (0:33) 0% (AMNH)

(66.) NEW MEXICO: *Hidalgo Co.:* 2 mi S of Rodeo, 3 May 1975, J. G. Rozen. (1:12) 8% (AMNH)

(67.) NEW MEXICO: *Hidalgo Co.:* 5 mi N of Rodeo, 1310 m, 6 May 1978, R. T. Schuh, ex *Chenopodium* sp. (Chenopodiaceae). (0:11) 0% (AMNH); #63–#67 **3%**

68. NEW MEXICO: *San Miguel Co.:* Montezuma, Gallinas Cyn., 22 Aug. 1972, L. A. Kelton. (0:14) **0%** (CNC)
69. NEW MEXICO: *Sandoval Co.:* Jemez Sprgs., 23 Aug. 1972, L. A. Kelton. (2:12) **14%** (CNC)
70. NEW MEXICO: *Santa Fe Co.:* Santa Fe, 23 Aug. 1972, L. A. Kelton. (4:21) **16%** (CNC)
71. NEW MEXICO: *Socorro Co.:* Magdalena, Cibola Nat'l. For., 21 Aug. 1972, L. A. Kelton. (2:96) **2%** (CNC)
72. OREGON: *Baker Co.:* 3 mi E of Baker, Conrad Allen Ranch, 6 Aug. 1963, C. W. Baker. (8:2) **80%** (OSU)

(73.) OREGON: *Benton Co.:* Corvallis, Willamette R., 4 May 1961, J. D. Lattin. (10:0) 100% (OSU)

(74.) OREGON: *Benton Co.:* Corvallis, Willamette R., 28 Sept., J. D. Lattin. (10:0) 100% (OSU); #73 and #74 **100%**

(75.) OREGON: *Deschutes Co.:* 8 mi SE of Brothers, 9 July 1968, J. D. Lattin, ex *Chrysothamnus vicidiflorus.* (0:14) **0%** (OSU)

(76.) OREGON: *Deschutes Co.:* 5 mi W of Redmond, 15 Aug. 1971, P. Oman. (0:18) **0%** (OSU)

(77.) OREGON: *Deschutes Co.:* Sisters, 3180′, 7 Aug. 1935, G. Ferguson, ex *Chrysothamnus* sp. (0:12) 0% (OSU)

(78.) OREGON: *Deschutes Co.:* nr, Sisters, 3300′, T14S R10E S15, 1 Oct. 1979, P. Oman. (0:17) 0% (OSU); #75–#78 **0%**

79. OREGON: *Jefferson Co.:* Madras, 13 Aug. 1949, V. Roth. (13:4) **76%** (OSU)

80. OREGON: *Harney Co.:* 6.5 mi N of Burns, 29 Apr. 1980, P. Oman. (9: 6) **60%** (OSU)

(81.) OREGON: *Harney Co.:* 5 mi E of Fish Lake, Steens Mts., 8250′, 16 July 1957, J. D. Lattin, ex *Helenium hoopesii.* (0:16) 0% (OSU)

(82.) OREGON: *Harney Co.:* 8 mi E of Frenchglen, 16 July 1957, J. D. Lattin, ex *Lupinus caudatus.* (0:12) 0% (OSU)

(83.) OREGON: *Harney Co.:* 2 mi N of Jupiter Ranch, 18 July 1957, J. D. Lattin. (0:22) 0% (OSU)

(84.) OREGON: *Harney Co.:* Mann's Lake, 30 May 1957, B. Malkin. (11: 11) 50% (OSU); #81–#84 **10%**

85. OREGON: *Lake Co.:* Hart Mt., 6250′, 2 Sept. 1977, J. Schuh, ex *Chrysothamnus* sp. (6:4) **60%** (AMNH)

(86.) OREGON: *Lake Co.:* Silver Lk., 11 mi N of Summer Lk. P. O., 16 May 1957, J. D. Lattin. (25:2) 93% (OSU)

(87.) OREGON: *Lake Co.:* Silver Lk., 28 June 1930, H. A. Scullen, ex *Chrysothamnus* sp. (1:31) 3% (OSU); #86–#87 **50%**

88. OREGON: *Lake Co.:* Summer Lk., 26 May 1957, B. Malkin. (1:14) **7%** (OSU)

89. OREGON: *Polk Co.:* Hwy. 99/Parker Rd., 11 May 1988, A. Asquith, ex *Lupinus* sp. (14:0) **100%** (OSU)

90. SOUTH DAKOTA: *Custer Co.:* Black Hills, 28 June 1973, L. A. Kelton. (0:15) **0%** (CNC)

91. SOUTH DAKOTA: *Lawrence Co.:* Spearfish, 23 Aug. 1957, R. F. Koontz, ex light. (0:37) **0%** (OSU)

92. TEXAS: *Brewster Co.:* Big Bend Nat'l. Park, Santa Elena Cyn., 2100′, 9 May 1959, W. R. M. Mason. (0: 16) **0%** (CNC)

93. TEXAS: *Culberson Co.:* 38 mi N of Van Horn, 1220 m, 28 Apr. 1978, R. T. Schuh, ex *Atriplex* sp. (Chenopodiaceae). (0:10) **0%** (AMNH)

(94.) UTAH: *Box Elder Co.:* Cedar Hill, 11 Aug. 1972, G. F. Knowlton, ex *Echinopsilon hyssopifolia.* (90:284) 23% (CNC)

(95.) UTAH: *Box Elder Co.:* Curlew Valley, 2 mi SE of Cedar Hills, 1 Sept. 1970, G. F. Knowlton, ex *Chrysothamnus viscidiflorus.* (12:18) 40% (OSU); #94 and #95 **32%**

96. UTAH: *Iron Co.:* Parowan, 25 July 1948, M. Cazier. (10:9) 53% (AMNH)

97. UTAH: *Utah Co.:* Salem, 25 July 1961, G. F. Knowlton. (1:9) 10% (CNC)

98. UTAH: *Sevier Co.:* 20 mi E of Salina, 18 Aug. 1957, W. F. Barr. (0: 18) **0%** (UID)

99. UTAH: *Washington Co.:* St. George, 1 Mar. 1966, G. F. Knowlton. (7:15) **32%** (CNC)

100. WASHINGTON: *Columbia Co.:* Dayton, 3 Aug. 1972, L. A. Kelton, ex turnip. (12:16) **67%** (CNC)

101. WYOMING: *Goshen Co.,* 7 May 1952, R. E. Pfadt. (0:15) **0%** (CNC)

102. WYOMING: *Natrona Co.:* Natrona, 12 Aug. 1962, J. G. & B. L. Rozen. (0:10) **0%** (AMNH)